Chapter 16
Practical Implications of Product-Based Environmental Legislation

Kieren Mayers

Abstract A number of approaches to industrial ecology are now employed within environmental legislation, targeting products at various stages of their life-cycle. These require producers to reduce the hazardous substances content of their products during production, increase product energy efficiency during use, and organise and finance improved recycling and treatment of their products at end of life (Extended Producer Responsibility, or 'EPR'). Such requirements are increasingly commonplace in the Americas, Eurasia, and Pacific Rim countries and have substantial impact. If companies can't comply, then they can't sell their products. There appears to be little research on the practical steps producers have taken to manage compliance with this new-wave of product-based requirements, as compared to the more established areas of environmental management addressing site-based air and water emissions, resource and energy use, and waste management. Based on a number of case studies, this chapter explains how such product-based legislation operates in practice.

Keywords Environmental legislation • Environmental management • Extended producer responsibility • Industrial ecology • Product-based legislation • Risk management • Supplier commitment

1 Introduction

Environmental legislation is increasingly targeting various stages of the product life-cycle. There are a widening range of restrictions on hazardous substances in different types of products globally, covering an increasing number of substances in their scope. To ensure their products comply, producers can ask the suppliers to commit to and sign declarations of compliance, audit production facilities, and

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undertake chemical testing of products. If these measures do not succeed, and producers are found to be non-compliant, corrective steps are needed to isolate and clear affected products from distribution.

Energy efficiency standards, including power caps, allowances, and power management, and information requirements, focus on reducing the energy used by a device to perform a particular defined task. For example, energy allowances are higher for categories of PCs with more powerful processors. Such standards do not necessarily result in an overall reduction in energy use of a product, as new products with increasing performance over time may use more energy overall, even if energy used per unit output falls.

Extended Producer Responsibility (EPR) legislation, requiring producers to finance and organise collection, treatment, and recycling of their products at end of life, has been enacted for a range of different types of products and in many different jurisdictions internationally. The main intention of such regulations is to ensure producers have financial incentives to design their products to be easier to treat and recycle at end-of-life, and also therefore to improve recycling and standards of environmental protection at end of life. Typically such regulations covers batteries, packaging, waste electrical and electronic products, tyres, household hazardous wastes, and automobiles in many areas of the world.[1]

This chapter draws on two decades of the author's personal experience working as an environmental/sustainability professional in the electronics and recycling sector within Europe, and also a number of associated case studies (Martin 2008; Webb 2014; Mayers 2007a, b; Mayers and Butler 2013) as an example of how producers respond to this new wave of product-based regulations. Content has also been taken from a presentation by the author prepared for a taught module on Life Cycle Assessment at the Centre for Environmental Strategy at the University of Surrey (Mayers 2011).

2 Dealing with Hazardous Substance Restrictions in Products

Regulations can target substance use in specific sectors, such as with the European Union (EU) Restriction of Hazardous Substances Directive covering electrical and electronic equipment (2011/65/EU) and the Packaging and Packaging Waste Directive (94/62/EC), or may focus on specific chemicals across product classes, such as with Danish lead restrictions (Danish Statutory Order No. 1012). The EU REACH Regulation (EC/1907/2006) takes a combined approach by restricting chemicals according to their specific applications. Overall, applicable substance limits depend on the product and material concerned. For example, as of January 2015, there are around 17 different hazardous substance regulations in Europe affecting Sony Computer Entertainment products, restricting 46 different substances, and including 78 different limit values for different types of products and materials.

[1] See special feature volume on EPR: Journal of Industrial Ecology, Vol. 17, Issue 2, 2013.

Typically, producers must consider at least five different factors when assessing the applicability of substance restrictions to their products:

- Which categories of products are in scope e.g. electronic, batteries, packaging?
- What is the limit value (allowable concentration per homogenous material or part)?
- When will restrictions be implemented?
- Which countries does it apply to?
- Which materials are affected e.g. plastics, solders, etc.?

The impacts of non-compliance, if caught, are severe. In the last year alone over 370 products were withdrawn from the market due to enforcement actions on hazardous substances within the EU (European Commission 2015). As well as halting sales, there is a reputational impact on brands, with governments and nongovernmental organisations (NGOs) generating exposure by naming and shaming companies in the media. To ensure they comply with such regulations, producers must (Martin 2008):

- Monitor and track continually evolving legislation
- Ensure products can meet prescribed limits
- Check that suppliers and factory management understand applicable requirements
- Plan phase-out of substances ahead of regulatory deadlines
- Check and approve parts and materials before shipping
- Retain technical documentation as evidence of compliance
- Correct non-compliance incidents
- Determine preventative and proactive measures to minimise risk of non-compliance

Supply chains can be extremely complex, involving networks of tens or hundreds of actors. Manufacturing activities are most commonly outsourced by brand holders to third parties. As a result, specific production processes may not be even known to or under the control of producers and brand-holders. Even if suppliers make stated commitments to phase out hazardous substances, and include requirements in documented specifications for new products, they may struggle to track and correctly interpret the plethora of different regulations globally. It may be challenging to find substitute materials, and so some companies may simply manufacture products that only comply with local or selected legislation. Upstream changes in suppliers or materials can result in unexpected changes to substance concentrations. Producers may also be unaware of chemical contaminants not deliberately added to their products e.g. black pigments may contain soot, which may contain a wide variety of heavy metals. Also, different laboratories may sample products differently with differing results. Finally, national authorities often take differing approaches to compliance and enforcement (Martin et al. 2007). In some countries, enforcement agencies test products selected from retail outlets to detect non-compliance; in others, a lack of technical documentation available from producers is considered to be an offence.

To protect against these risks and manage elimination of hazardous substances in their products, producers can use a combination of approaches. As a basic underpinning and assurance, producers can ask their third party manufacturers and suppliers to complete and sign declarations that they will ensure all materials, components or products comply with all hazardous substance restrictions applicable in the jurisdictions where the product will be distributed. First and foremost, this alerts suppliers to the necessary requirements. It also may provide some assurance to producers in terms of liability for any resulting financial losses. Signed supplier declarations, however, do not provide guarantees that the products themselves will be in compliance. Government authorities often find quite a high proportion of products investigated through market surveillance do not actually comply with substance restrictions. For an example, in 2014, the Swedish Chemicals Agency found that over 40 % of the plastic articles such as handbags, wallets, pencil boxes and cases for mobile phones that they tested contained short-chain chlorinated paraffins which are prohibited under the EU Persistent Organic Pollutants Regulation (KEMI 2014).

To minimise risk further, producers can submit samples of products for testing at laboratories, undertake chemical testing themselves or ask suppliers to provide test reports that show their products meet legal limits. Testing provides a robust check; for example, test reports can be used to detect any substances suppliers are unaware of from sources ‘upstream’ in their supply chain. Alongside signed supplier declarations, test reports can also be used to show regulatory enforcement agencies documented evidence of due diligence. Testing, however, also has its limitations: it only provides a ‘snap-shot’ of one or perhaps a few products at one point in time, so multiple samples may be needed as well as retesting on periodic basis e.g. monthly, quarterly, or annually. As testing is expensive and samples are usually destroyed in the testing process, testing statistically representative samples of products can be infeasible.

To gain an overall perspective and level of assurance, producers can also audit their supplier’s manufacturing facilities. Auditing can be used to ascertain the level of competency and understanding of staff working in manufacturing, ensure the necessary controls are actually in place, check the effectiveness of procedures used to control hazardous substances, and assess unforeseen risks in the process. For example, if manufacturers do not have a process to isolate any products suspected to have compliance issues from compliant stock, then there is a risk the products may enter the supply chain. The limitation of such audits is that they too only provide a ‘snap shot’ in time of how any supplier may be operating. Audits should, therefore, be repeated every year or so, but this may involve a substantial amount of time and resources as global supply chains typically have many different suppliers involved.

For any new substance compliance requirements, producers must ensure their products comply by time they come into force. There are several different approaches to stock control that can be used to clear-out older stocks of non-compliant products (Fig. 16.1).

If preventative measures fail and non-compliant products enter distribution (where, in the worst-case, producers may face fines and sales prohibitions), then corrective measures are needed both to identify any current non-compliant stocks of

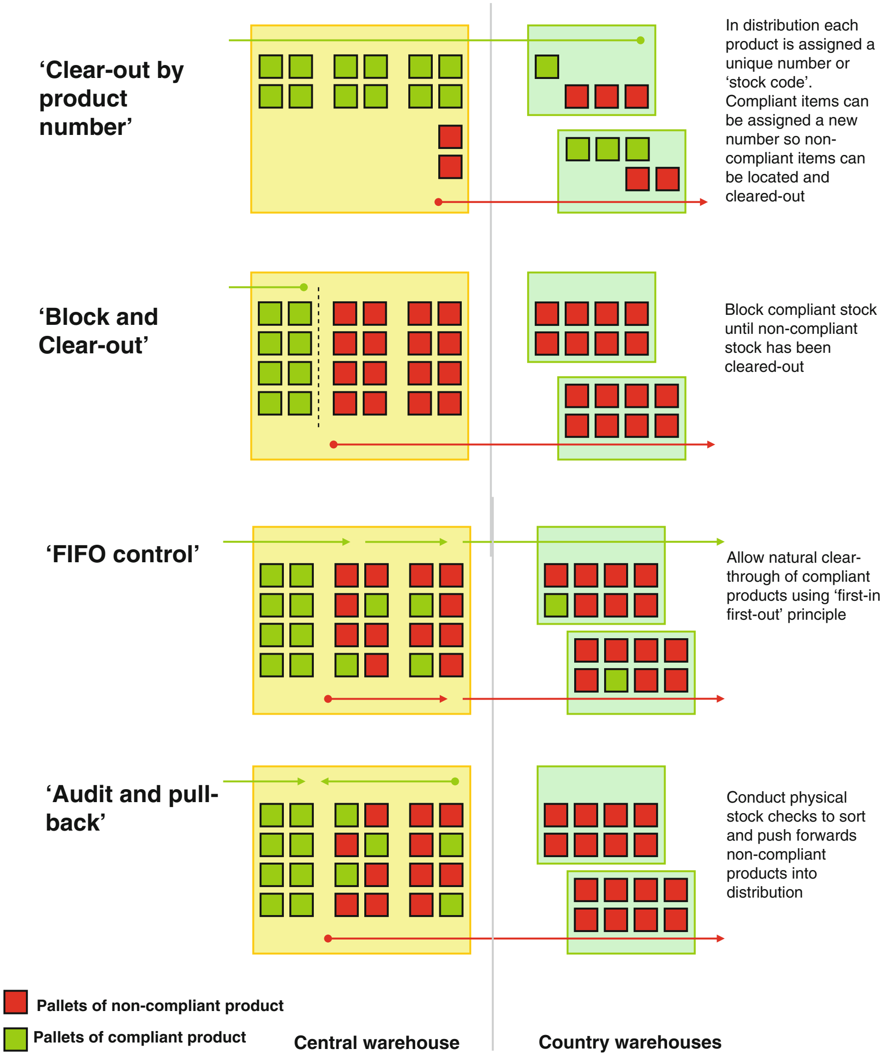

Fig. 16.1 Stock management approaches to clear-out non-compliant products (Adapted from Mayers 2011)

products, and also to find and fix whatever oversight or issue is at cause. A producer's supply chain may be made up of both pan-regional, and state or national warehouses, filled with millions of units of potentially hundreds of different product lines. Each product line may be supplied by several different manufacturers. Producers must ascertain which products are affected; whether it is just products from one supplier in particular, all products, or just those manufactured in a certain time period. The compliance issue may be related only to specific components or materials e.g. lead in plastic could be from either the pigment or plasticiser used (Fig. 16.2).

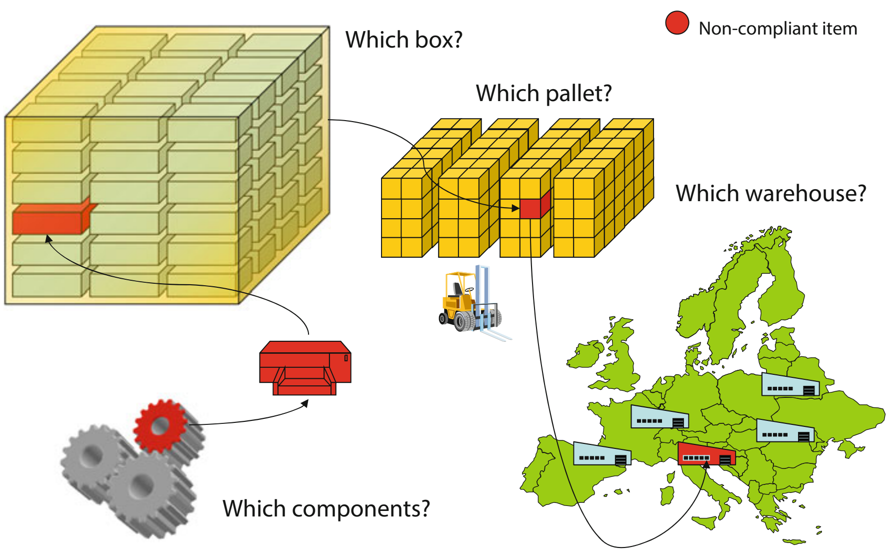

Fig. 16.2 Distinguishing non-compliant products in a supply chain (Adapted from Mayers (2007a, b). Lifecycle environmental management in the electronics sector. Lecture, University of Surrey, 12 January)

Not all of these factors are easy to assess or understand, and it may not be straight forward to distinguish stocks of compliant from non-compliant products across many warehouses. As a consequence, producers may have to send many samples of product for testing to try to determine which products in their supply chain are affected. Once identified, producers may have to take a number of actions: they may have to rework or replace non-compliant items e.g. power cables, they may dispose of the items if there is no other option feasible, or they may return the products to the original manufacturer for a refund (which is where the signed declaration can be of use).

To solve the problem at source, suppliers must identify and address (a) what went wrong, (b) how it can be fixed, and (c) what can be done to preventive recurrence.

3 Ensuring Energy Efficiency

Energy using products are covered by a range of different types of energy standards worldwide. Focusing on electrical and electronic products these include:

- Requirements for power management, such that a device switches automatically into the lowest power mode possible for the function required.
- Reductions in power consumption, where the power consumed for a given task is reduced, such as modal power caps or allowances.
- Requirements to inform consumers and users and label devices on their energy use, and how to use them in a way to minimise energy use.

Standards may involve voluntary commitments, such as US Energy Star (US Environmental Protection Agency 2015), or sector voluntary agreements used in the EU (2009/125/EC), US (US Department of Energy 2015a), Australia and New Zealand (E3 2015a); regulatory requirements, such as EU Energy Using Products (2009/125/EC) and Energy Labelling Directives (2010/30/EU), and Australia and New Zealand Minimum Energy Performance Standards (E3 2015b), and US Federal energy efficiency standards (US Department of Energy 2015b); or regulatory benchmarks, such as Japan's 'top runner' programme to ensure all best technologies are adopted over time according to leading products on the market (Energy Conservation Centre Japan 2015).

As technological development and innovation occurs relatively rapidly, energy efficiency requirements are typically organised into a succession of chronological 'tiers' over which requirements are ratcheted up. To comply producers may either need to retain technical documentation and test reports showing that their products meet each of the applicable criteria (as in the EU and Australia), or in some cases may be required to submit their products themselves for testing and certification (as under US Energy Star requirements). Non-compliant products may either lose their certification status and must withdraw or change energy labels used, or ultimately, if mandatory standards are involved, producers may face fines and sales blocks.

The most complex challenge for producers is to understand and keep pace with the future energy implications of technological development. With the pace of technological advancement, energy efficiency standards are updated every few years to ensure improvement vs. 'business as usual'. Such assessments consider and compare estimates of total energy use for any potential improvements, considering power consumed, usage time, and number of units of a product in use to calculate estimates of total electricity consumption (TEC).

To engage in this process, producers need in-depth understanding and available research on their consumer usage behaviour, and the energy implications of different technology scenarios, to consider energy implications at the early stages of product development, and also to engage with and gain the understanding of stakeholders such as environmental and consumer NGOs. Predicting power consumption of future technology 3–4 years in advance, considering the timescales for developing new regulations, involves large amounts of risk for producer. Where it may not be clear the extent to which a new energy efficient technology may be suitable, or what implications it may have, further research and development may be needed. Unless producers engage in continuous dialogue with policy makers and NGO stakeholders at an early stage, regulations and standards may be developed based on only rudimentary understanding of their products and services, which may not result in optimal solutions to energy efficiency and may impede innovation.

Compliance with energy standards appears relatively straight forward in comparison to substance compliance (discussed above) and Extended Producer Responsibility (EPR) (discussed below). This is because standards are uniformly applied and relatively easy to assess. The challenge for producers is to anticipate and even influence the direction of future energy policy and standards. If producers are unable to keep pace and comply with these evolving standards, they may be forced to withdraw many of their products, as recently observed for vacuum cleaners that could not meet 1,800 W power cap within the EU (BBC 2014).

4 Managing Products at End of Life

There are many thousands of different producers, and usually many hundreds or thousands of waste collection points within any country. As a consequence, under EPR it is absolutely infeasible for each producer to set-up an individual system to collect their own branded products from all possible municipal collection centres and households. Conversely, it would also be an overwhelming task for each householder, or municipal waste collection point, to sort all their waste by hundreds of brands on a daily basis and try work out which producer to contact to arrange collection (assuming even that the original producer still exists).

This insurmountable 'economy of scope' limits the effectiveness of EPR in practice; producers have little option other than to co-operate and manage waste collectively within each country. To this end producers have established Producer Recycling Organisations (PROs) to manage and administer waste arrangements on their behalf (Fig. 16.3). Based on 2014 data, over 400 EPR systems (most of which include *at least* one PRO) have been established worldwide (Lifset 2014).

Setting-up and running PROs can be quite an involved process (Mayers and Butler 2013). PROs must organise sufficient management, expert, and administrative staff to organise their activities. Management overheads can, therefore, constitute up to 20 % of overall PRO expenditure. There can be considered to be three stages to PRO implementation: 'design', 'build', and 'operate':

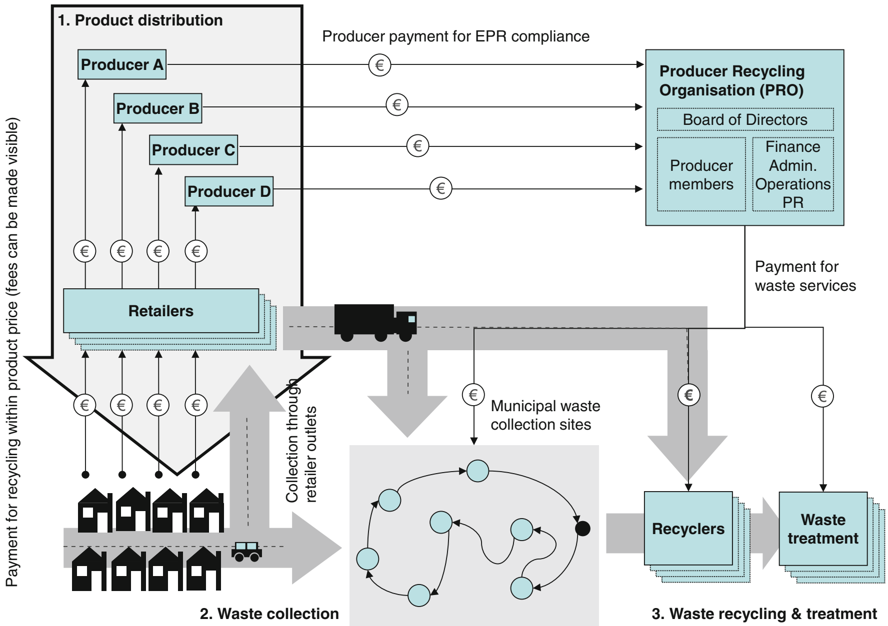

Fig. 16.3 Producer recycling organisation set-up and operation (Mayers 2007a)

- PRO planning and system design:
  - Investigating existing waste infrastructure and legislation
  - Determining PRO license conditions and requirements
  - Identifying where waste materials arise, and how the PRO will access them
  - Assessing which recycling services are available, and at what price
  - Agreeing how competing PROs will balance their share of waste
- Building-up PRO operations and processes:
  - Appointing PRO staff, and setting-up administration and reporting procedures
  - Auditing and approval of recycling companies against required standards
  - Deciding on containers and transport needed for each collection point
  - Selecting and appointing recyclers and collection companies
- Running ongoing operations:
  - Receiving and responding to requests for collection
  - Organising day-to-day collection, treatment, and recycling
  - Collating and submitting reports of quantities collected and processed
  - Accounting and payment for collection, treatment, and recycling services
  - Trouble-shooting operational and service problems
  - Optimising activities to meet cost and key performance indicators

To comply with EPR legislation, producers must firstly understand specific regulatory requirements within each country for each type of product. Different regulations may specify different requirements relevant to each producer, for example reporting and registration procedures. Once requirements have been checked, producers must choose which PROs are most appropriate for their products. It may be possible to choose between several competing PRO services. Some key considerations for producers to take into account before joining a PRO include:

- Does the PRO charge a membership fee? How often and how much?
- Are recycling fees fixed per product sold in advance, or will the amount charged vary according to the producer's share of treatment and recycling costs each month?
- Does the PRO accrue any financial reserves from the payments producers make? Who owns those funds and for what purpose?
- Does the PRO have the necessary permits and authorisations to operate and fulfil the producer's EPR obligations? Will it ensure the necessary environment standards?
- How long is the contract period for? Under which conditions can the PRO terminate the contract?
- Once the contract is agreed, are fees fixed or can they be changed by the PRO from time to time? Under what conditions can the PRO increase or lower their fees?

- Is the exact wording of the contract fixed, or can it be varied according to each member producer's policies?
- How often does the PRO require reporting? Annually, quarterly, or monthly?
- Are there any other useful services the PRO can provide e.g. collection of WEEE from offices, or pan-European EPR compliance services?

Once producers have signed-up to their selected PRO, they must then start reporting the amount of products sold and pay any PRO charges due to finance collection, treatment, and recycling as well as any management and administrative overhead. Reporting requirements between different countries, types of waste, and PROs can differ widely e.g. units vs. weight sold, reporting by different sub-categories of products and materials, monthly, quarterly, or annual reporting, or reporting to PROs, national enforcement agencies, or special registration or 'clearing house' bodies. Typically producers will have a list of components used in their products (bill of materials) available, but will not be necessarily aware of the weight of different packaging materials, or the weight of electronic products with cables but without batteries, etc. Collecting and then reporting such data, combining it with sales reports, and completing different formats of reporting forms for different PROs and different waste streams takes time for operations and environmental managers.

Unfortunately, financial incentives for improved design of products from EPR are limited to non-existent. Recycling fees tend to be higher for plastics than for card and paper packaging, as plastics are more complex to recycle. This provides some incentives towards use of paper packaging, but not for the packaging to be designed in a way to ensure it can be easily recycled e.g. easily separated into different material types rather than being glued together. In addition, all EPR fees are charged per unit or weight sold, which will only reward producers if they sell fewer products or sell smaller products (in the case of weight sold). As products are recycled collectively, and costs shared equally among producers, incentives for each individual producer for their own products are removed or diminished substantially.

The economies of scope explained above means that it is impractical for producers to collect and recycle only their own products in an individual EPR system. Separation of products into thousands of brands at municipal collection points with only enough space and staff to provide a few waste containers is logistically impossible. At the household level, putting aside the sheer impracticality of sorting for 'kerbside' or 'doorstep' collection, it would not be environmentally beneficial to arrange individual collections of waste by brand due to the need for dedicated transport for small volumes. In addition, collection costs would outweigh any recycling value or cost by several orders of magnitude (for example, consider the costs of mailing individual parcels).

Collective PRO systems appear to be a necessary component of EPR. Nevertheless, individual producers can still be made financially responsible for waste costs attributable to their products. PROs can allocate costs to producers more accurately and proportionately based upon the treatment and recycling costs of different types of products (Mayers et al. 2014). For example, display screens with mercury backlights must be treated before recycling to remove mercury, which is an expensive process, whereas mercury-free LCDs can be more conventionally recycled, potentially with a net value. This approach is already in place in France for packaging and WEEE, using a system of differentiated fees.

While EPR was developed with good motives, in practice its implementation is both administratively and logistically complex, and to date the main purpose to incentivise design is largely unfulfilled.

5 Discussion and Conclusion

Looking back, site-based approaches to environmental management, developed since mid-seventies, focus on treating environmental problems at 'end of pipe'. Education in environmental management and sciences from this time focussed mainly on environmental problems and their causes, environmental protection legislation, environmental management systems, air and water monitoring, water treatment and air pollution control, waste management, and resource and energy use. Such knowledge is important in managing and reducing the environmental impact of any particular industrial operation.

Looking forward, managing environmental impacts of the life-cycle of products from raw material extraction to end-of-life involves altogether different issues, requiring additional skills from environmental and 'sustainability' managers. In addition to a basis of understanding of current environmental issues, sociology, ethics, economics, and sustainable development, risk assessment and management, and life-cycle assessment methods, further expertise is essential as listed below:

- Managing hazardous substances in supply chains:
  - Substance compliance regulations
  - Materials usage and engineering
  - Product testing and chemical analysis
  - Supply chain management
  - Stock control and auditing
- Ensuring energy efficiency of products:
  - Energy efficiency legislation
  - Product development and engineering
  - Government relations and stakeholder engagement
  - International standardisation processes
  - Consumer behaviour and market research
  - Product testing and power measurement
- Implementing EPR for wastes:
  - EPR legislation
  - Contract management for PROs
  - Recycling standards and technologies
  - Company accounting systems such as SAP to report sales volumes

Managing flows of hazardous substances, recyclable materials, and energy use throughout the life-cycle of products and considering entire industrial supply chains with the aim of reducing their environmental impact are administratively and logistically complex. Producers often do not have complete knowledge or direct control of complex supply chains and cannot always accurately predict the future outcomes of technology development. Environmental managers must find new ways to address gaps in understanding and implement procedures to ensure producers can comply with this new wave of product-based environmental legislation, and ultimately to solve and prevent environmental problems at source.

There appears to be very little corresponding information or knowledge of contemporary approaches to environmental management in the available literature, and furthermore, students may miss out if further education only equips them with knowledge to understand and assess the implications from a life-cycle or sustainability perspective. For example, imagine a surgeon only taught how to diagnose heart disease, but not how to conduct heart surgery. From a policy perspective, lessons from practical experience reinforce the need for harmonised product-based requirements including applicable standards, product categorisation, reporting, and proof of compliance. For industrial ecology to move forwards, the practical challenges and approaches, the administrative procedures, and the management methods required to solve environmental problems at various stages of a product's lifecycle are surely worth further consideration.

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